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Putting on a Tight Leash and Levelling Playing Field: An Experiment in Strategic Obfuscation and Consumer Protection*

Yiquan Gu[1,†] Tobias Wenzel[2,3,‡]

[1]University of Liverpool

[2]University of Bath

[3]Düsseldorf Institute for Competition Economics (DICE)

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Abstract

The paper reports the results of an experiment where asymmetric sellers of a product can obfuscate the market. We show that policy measures may have unintended effects of increasing obfuscation incentives. We find that policies that limit the effectiveness of obfuscation and policies that promote parity between firms can lead less prominent firms to increase their obfuscation efforts. Despite this unintended effect, however, the former type of policies is effective in boosting consumer welfare.

JEL Classification: C91; D18; D43; L13

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†Email: yiquan.gu@liv.ac.uk; Address: University of Liverpool, Management School, Chatham Street, Liverpool, L69 7ZH, United Kingdom.

‡Email: t.wenzel@bath.ac.uk; Address: University of Bath, Department of Economics, Claverton Down, Bath, BA2 7AY, United Kingdom.

1 Introduction

It is well documented in a variety of markets that consumers often make sub-optimal choices.[1] On the other hand, the supply side of the market has been associated with strategies that are designed to exploit imperfection in consumer decision making. In particular, firms may deliberately increase the complexity in which relevant information is presented in order to confuse consumers. For example, in the retail financial industry, firms often use complex language or invent new terms in the description of their products. Such obfuscation strategies make it more difficult for consumers to compare available offers, and hence ease competitive pressure in pricing and can have substantial welfare consequences for consumers (Calvet et al., 2007; Campbell, 2006).

An important question in such a situation is whether traditional public policies can effectively discourage supply side obfuscation and protect consumers from such practice. To answer this question, we first analyse a simple game of strategic obfuscation and then test model predictions in a laboratory setting. To reflect observations in real markets, we allow the firms to differ in prominence, i.e., their ability in attracting naive consumers. In such a framework, we study the effects of two common policy measures: policies that directly protect consumers by hampering the effectiveness of obfuscation (Putting on a Tight Leash)[2] and policies that promote parity between firms (Levelling Playing Field).[3]

In our simple model with a binary choice of obfuscation, it is found that the more prominent firm always chooses to obfuscate. However, the incen-

[1]Imperfect consumer decisions are well documented in telecommunication markets (Miravete, 2013), electricity markets (Wilson and Waddams, 2010), and in particular, retail financial markets where a number of reasons have been identified including cognitive limitations (Calvet et al., 2009), behavioural biases (Stango and Zinman, 2009) and insufficient knowledge (Lusardi and Mitchell, 2007; van Rooij et al., 2011), among others.

[2]Such policies might include, for instance, policies that prohibit certain obfuscation tactics or educational programmes to directly improve consumer decision making.

[3]For example, in some economies, state owned firms play an important role and often enjoy a higher level of prominence or trust than privately owned firms. Privatisation, which may be proposed to address various objectives, can reduce asymmetry in firms' prominence levels.

As another example, consider the case where continued persuasive advertising is required to maintain brand loyalty and the resultant superior prominence. Policies that impose spending limits on advertising thus can level the market in terms of prominence over time. We study the effects of such policies in relation to obfuscation.

tives of the less prominent firm to obfuscate are ambiguous. The incentives to obfuscate depend on the extent of asymmetry, but also on the level of consumer protection policy. In the model, a stronger consumer protection policy reduces the effectiveness of firms' obfuscation strategies. This theoretical model yields two surprising hypotheses. First, an increase in the level of consumer protection policy may actually induce the less prominent firm to obfuscate. Second, policies that promote parity between the firms may also increase the propensity of obfuscation by the less prominent firm. To test these hypotheses, we design an experiment where in the base treatment two rather asymmetric firms compete in obfuscation and prices. We then implement two treatments where in the first, the level of consumer protection policy is strengthened, and in the second, firms are more symmetric than they are in the base treatment. It is found that our experimental evidence broadly supports the above two theoretical hypotheses.

Although both policy measures increase the propensity of the less prominent firm to obfuscate, our experimental results show that the effects on consumer welfare are very different. Policies that promote parity increase obfuscation. Hence, the share of naive consumers and product prices rise. This unequivocally harms consumers. However, we note that consumer protection policies are found to be effective in reducing the share of naive consumers and consequently the prices consumers pay, despite the increased propensity of obfuscation by the less prominent firm.

The literature on competition in the presence of behaviourally biased consumers is growing rapidly.[4] Piccione and Spiegler (2012) offer a framework of obfuscation where firms can choose different price frames. In an earlier version, Piccione and Spiegler (2009), the authors also consider prominence such that when unable to compare offers their consumers buy from the incumbent. In equilibrium, the prominent firm (the incumbent) minimises comparability while the non-prominent firm (the entrant) does the opposite. In contrast, in our theoretical model firms directly choose obfuscation as in Carlin (2009), and the degree of prominence can vary continuously. Additionally, we study the impact of various policy measures in an asymmetric setting. Chioveanu and Zhou (2013) provide another analysis that allows for the distinction of frame complexity and frame differentiation.

[4] See Spiegler (2011) for a textbook treatment and Huck and Zhou (2011) for an overview.

Spiegler (2014) offers a general duopoly framework that captures a variety of obfuscation strategies. Gu and Wenzel (2014) develop a theoretical model of strategic obfuscation and analyse the effects of consumer protection policies. The experimental setting of the present paper is built on this model.

Although most of the contributions so far are theoretical, there have also been a few experimental studies. Kalayci and Potters (2011) examine whether buyer confusion increases market prices and find results that support the effectiveness of buyer confusion. Kalayci (2015) presents experimental evidence that a seller's complexity and price choices are positively correlated. This is in contrast to the findings in Sitzia and Zizzo (2011) where the authors are unable to detect a significant effect of product complexity on prices. Kalayci (2012) investigates the effect of competition – captured by the number of sellers – on complexity choice. Contrary to theoretical predictions in Carlin (2009), Kalayci (2012) finds that an increase in the number of sellers does not affect a seller's complexity choice. Normann and Wenzel (2014) present an experiment where sellers can coordinate shrouding of an add-on product and find that the shrouding does only occur in concentrated markets. Relatedly, Crosetto and Gaudeul (2014) report an experiment where sellers can choose a price format. They find that, if rival's behaviour is observable, firms are able to coordinate on shrouded formats. Finally, our paper is also related to Morgan et al. (2006) which studies price distributions in the presence of uninformed consumers.

The remainder of the paper is organised as follows. In Section 2 we describe the model that is used for our experimental setup. Section 3 specifies the design of the experiment and derives the hypotheses. In Section 4 we report the results of the experimental study. Finally, Section 5 concludes.

2 Theoretical background

2.1 Model

To provide guidance for the experimental design, in this section we outline a simplified model of strategic obfuscation following Gu and Wenzel (2014).

We consider a market where two firms compete to supply a homogeneous product to a mass one of consumers each demanding one unit of the product when the reservation price of $r > 0$ is not exceeded. Consumers are either sophisticated or naive. Sophisticated consumers can compare prices and buy from the firm that offers the lowest price. Naive consumers, on the other hand, are unable to compare prices and buy at random with a distribution to be specified below.

Shares of respective consumers are influenced by firms' obfuscation choices and the consumer protection policy. Naturally, more obfuscation and low consumer protection lead to more naive consumers and accordingly, fewer sophisticated consumers. Departing from Gu and Wenzel (2014), here we treat obfuscation as a binary choice.[5] Specifically, let $I_i \in \{0, 1\}$ be an indicator variable that takes the value 1 if Firm i decides to obfuscate and 0 otherwise, and let $x \in (0, 1)$ be the level of the consumer protection policy. The share of naive buyers then is

$$\mu(x, I_1, I_2) = (1 - x)\frac{I_1 + I_2}{2}. \tag{1}$$

The proportion of sophisticated consumers is thus $1 - \mu(x, I_1, I_2)$.

We allow the firms to differ in their abilities in attracting naive consumers.[6] Without loss of generality, Firm 1 is designated as the more prominent firm which captures a larger share, $\phi \in \left(\frac{1}{2}, 1\right)$, of naive consumers. Firm 2 receives the rest of those naive consumers $1 - \phi$. We normalise both firms' production costs to zero and we assume obfuscation is costless.

The timing of the game is as follows. In stage 1, the two firms simultaneously and independently decide on its own choice of obfuscation. After knowing each other's obfuscation choice, and hence the share of naive consumers, they compete in prices in the second stage.

[5] An obfuscation strategy might, for instance, correspond to the use of different terms and language - as can be observed in financial markets - which makes it harder for some consumers to fully understand pricing and, hence, impedes comparisons between different offers.

[6] This reflects the observation that when unable to compare prices, consumers often resort to factors like past experiences, firm reputation, name recognition, etc.

2.2 Theoretical results

Since a more elaborated version of the model has been fully analysed in Gu and Wenzel (2014), we only highlight main results here.

In the second stage, there exists a unique Nash equilibrium in mixed strategies (Varian, 1980; Narasimhan, 1988). As the more prominent Firm 1 receives more naive consumers than Firm 2, its opportunity costs of competing aggressively for sophisticated consumers are higher. As a result, Firm 1 sets higher prices in equilibrium than Firm 2 in the usual stochastic order. As our first theoretical prediction, we note:

Proposition 1. Firm 1 sets higher prices in equilibrium than Firm 2 in the usual stochastic order.

Equilibrium profits are

$$E(\Pi_1) = \phi\mu r \text{ and } E(\Pi_2) = \frac{(1-\phi\mu)\phi\mu r}{\phi\mu + (1-\mu)}. \tag{2}$$

Note that Firm 1's expected profit is equal to the level it could make by focusing only on its own share of naive consumers while Firm 2's is higher than it would make by selling only to its naive consumers. In this sense, Firm 2 benefits from the presence of sophisticated consumers.

In the first stage, Firm 1 chooses to obfuscate since its expected profit increases strictly in the share of naive consumers. For Firm 2, however, whether obfuscation increases or decreases profits depends on the asymmetry ϕ and the effectiveness of obfuscation in increasing the share of naive consumers.

Proposition 2. For a given combination of consumer protection policy x and asymmetry in prominence ϕ, equilibrium obfuscation is as follows.

1. The more prominent Firm 1 chooses to obfuscate, $I_1^* = 1$.
2. Define $\tilde{\phi} := \frac{\sqrt{(x+2)^2+8}-(x+2)}{2(1-x)}$.
   (a) If $\phi < \tilde{\phi}$, the less prominent Firm 2 chooses to obfuscate, $I_2^* = 1$;

(b) If $\phi = \tilde{\phi}$, the less prominent Firm 2 is indifferent between obfuscation and no obfuscation;

(c) If $\phi > \tilde{\phi}$, the less prominent Firm 2 chooses not to obfuscate, $I_2^* = 0$.

Proof: As $E(\Pi_1) = \phi\mu r$, Firm 1's profits strictly increase in μ and hence $I_1^* = 1$. Given this, Firm 2 chooses between $\mu(x, 1, 1) = \overline{\mu} = 1 - x$ which is obtained by obfuscation, and $\mu(x, 1, 0) = \underline{\mu} = \frac{1-x}{2}$ by no obfuscation. The proposition then follows because

$$\phi \lesseqgtr \tilde{\phi} \Leftarrow E(\Pi_2; \overline{\mu}) = \frac{(1-\phi\overline{\mu})\phi\overline{\mu}r}{\phi\overline{\mu} + (1-\overline{\mu})} \gtreqless \frac{(1-\phi\underline{\mu})\phi\underline{\mu}r}{\phi\underline{\mu} + (1-\underline{\mu})} = E(\Pi_2; \underline{\mu}).$$

Q.E.D.

In general, Firm 1 has larger incentives to obfuscate than Firm 2. Intuitively, when deciding on whether or not to obfuscate, Firm 2 weighs an increased demand from naive consumers and a softened price competition against the associated decrease in the demand from sophisticated consumers. When the two firms are rather asymmetric ($\phi > \tilde{\phi}$), Firm 2 is better off with no obfuscation and competing for sophisticated consumers since the number of naive consumers it would receive by obfuscation is rather small. On the other hand, when the two firms are rather symmetric ($\phi < \tilde{\phi}$), Firm 2 benefits from obfuscation as the combined positive effect of reduced price competition and more naive consumers dominates the negative effect resulting from fewer sophisticated consumers.[7]

With equilibrium obfuscation, we can derive the equilibrium share of naive consumers for a given combination of x and ϕ.

Proposition 3. The share of naive consumers in equilibrium is

$$\mu^* = \begin{cases} 1-x & \text{if } \phi < \tilde{\phi} \\ 1-x \text{ or } \frac{1-x}{2} & \text{if } \phi = \tilde{\phi} \\ \frac{1-x}{2} & \text{if } \phi > \tilde{\phi}. \end{cases} \tag{3}$$

[7] Note that for $x > \frac{1}{3}$, $\tilde{\phi} > 1$ and it follows that Firm 2 always obfuscates.

A direct implication of Proposition 2 and 3 concerning a change in asymmetry is the following result.

Proposition 4. For a given consumer protection policy x, if the measure of asymmetry ϕ decreases from above $\tilde{\phi} = \frac{\sqrt{(x+2)^2+8}-(x+2)}{2(1-x)}$ to below $\tilde{\phi}$, Firm 2 switches from no obfuscation to obfuscation and the share of naive consumers doubles from $\frac{1-x}{2}$ to $(1-x)$.

On the other hand, if we hold asymmetry fixed, an increase in the consumer protection policy x may induce Firm 2 to obfuscate. To see this, note first that $\tilde{\phi}$ as defined in Proposition 2 increases in x. It follows that if previously $\phi > \tilde{\phi}(x_1)$ and $\phi < \tilde{\phi}(x_2)$ after the strengthening of the consumer protection policy ($x_2 > x_1$), Firm 2 switches from no obfuscation to obfuscation. Accordingly, the share of naive consumers changes from $\frac{1-x_1}{2}$ to $1-x_2$. To summarise:

Proposition 5. For a given level of asymmetry ϕ, if the increase in consumer protection policy from x_1 to x_2 is such that $\tilde{\phi}(x_1) < \phi < \tilde{\phi}(x_2)$, Firm 2 switches from no obfuscation to obfuscation. Accordingly, the share of naive consumers changes from $\frac{1-x_1}{2}$ to $1-x_2$.

2.3 Concerns for relative profits

In our model the effects of obfuscation on firms' profits are quite asymmetric. Even in cases where Firm 2 benefits from choosing to obfuscate Firm 1's profits would increase even more, that is, with Firm 2 obfuscating the profit gap between the two firms widens. Here, we discuss how the model's predictions would change if firm managers not only care about their profit level, but also about relative profits.

Concerns for relative profits may indeed influence firm behaviour (Armstrong and Huck, 2010). For instance, firms or rather firm managers might be concerned with relative profits because relative performance might be an important factor for future career opportunities. Managers who have performed relatively well compared to their peers may have better job prospects in the future. Managers may also face incentive contracts that deviate from pure profit maximisation and which might include relative performance measures (Gibbons and Murphy, 1990). It might also be the case that firm managers or CEOs are intrinsically competitive and have innate preferences regarding relative standings (Armstrong and Huck, 2010). Moreover, evolutionary models of oligopolistic competition also argue that relative profits may matter for firm / manager survival (e.g., Schaffer, 1989; Hehenkamp and Wambach, 2010).

Let us discuss how our model's results are affected if relative profits concerns are taken into account.[8] As with profit maximisation pricing in the second stage of the game is in mixed strategies, and Firm 1 charges on average a higher price than Firm 2. However, when managers are concerned of relative profits, pricing will become more competitive. The new prices are stochastically dominated by that of the standard profit maximisation, and the lower bound of the price distributions also decreases. The reason is that a firm that finds it is undercut by the competitor suffers not only the loss of the share of sophisticated consumers to the competitor, but also finds it profits much reduced in comparison to the competitor. This increases a firm's incentive to charge lower prices, and in equilibrium, the price distribution and average prices are lower than with profit maximisation. In the first stage, the obfuscation incentives remain comparable to the standard case. However, while the more prominent firm still prefers to obfuscate as much as possible, Firm 2's obfuscation incentives are reduced as obfuscation may increase the more prominent firm's profits even more. Thus, when relative profits matter we should expect Firm 2 to obfuscate to a smaller extent than with pure profit maximisation. The strength of this effect depends, of course, on the degree of relative profit concerns.

3 Experimental design and hypotheses

3.1 Experimental Design

Our main goal is to analyse the impact of consumer protection and asymmetry on obfuscation choices. We therefore ran sessions with different levels

[8] In Appendix A we provide a formal derivation of the following verbal discussion.

Treatment	Asymmetry ϕ	Policy x	$\frac{100(1-x)}{2}$	Participants	# Groups
BASE	0.9	0.2	40	56	7
POL	0.9	0.6	20	56	7
SYM	0.6	0.2	40	56	7

Table 1: Treatments

of consumer protection and asymmetry.

We consider markets with 100 buyers where each buyer purchases exactly one unit. Buyers are programmed so that sophisticated buyers choose to buy from the seller charging the lowest price, while each seller receives his share of the naive buyers independent of the price charged. In case of a tie sophisticated buyers are also divided according to the same rule as with the naive buyers.

With obfuscation choices I_i and consumer protection parameter x, the number of naive buyers is $100(1-x)\frac{I_1+I_2}{2}$. Instead of providing the value of x directly to participants, we report the value $\frac{100(1-x)}{2}$ which can be more easily interpreted as the increase in the number of naive consumers for every obfuscating firm.

At the start of each period, sellers are randomly matched into groups of two competing sellers: one subject is randomly assigned the role of Firm 1 and the other subject is assigned the role of Firm 2. In the first stage, each seller decides whether or not to obfuscate which increases the number of naive buyers by 40 (20). The decisions are revealed to both sellers, and in the second stage of each round, each seller determines its price which has to be an integer in $[0, 100]$. At the end of each round, participants are informed about the competitor's price, the quantities sold to sophisticated and naive buyers as well as the profit earned in this period. This stage game is repeated for 25 periods with a random-matching procedure mimicking the one-shot nature of our theoretical model. Note also that subjects may switch roles between periods. Whether a participant takes the role of Firm 1 or of Firm 2 is randomly determined in each period.

We have run three treatments - see Table 1. In our base treatment BASE, the asymmetry level is high with $\phi = 0.9$ and each obfuscating firm increases

	BASE	POL	SYM
Obf. by Firm 1	1	1	1
Obf. by Firm 2	0	1	1
Naive consumers	40	40	80
Avg. price	60.0	60.0	84.7
Min. price	37.5	37.5	70.6
Consumer surplus	40	40	15.3

Table 2: Theoretical predictions

the number of naive consumers by 40. In treatment POL, mimicking the effect of consumer protection, we reduce the effectiveness of obfuscation to 20. Finally, in treatment SYM we reduce the asymmetry level to $\phi = 0.6$. For each treatment, we have seven independent observations (corresponding to the number of matching groups each consisting of 8 participants). Table 2 summarises, assuming profit-maximising firms, the point predictions of the three treatments .

All sessions were conducted at the experimental economics laboratory at the University of Düsseldorf. The experiment was implemented using the software z-Tree (Fischbacher, 2007). Appendix B contains an English translation of the instructions. Subjects received a show-up fee of 4 EUR and could earn additional amounts during the experiment. On average, participants received an amount of 13 EUR for a 60-minute session. In total, 168 subjects participated in our experiment. No subject participated in more than one session and none of the subjects had ever participated in any similar experiment before.

3.2 Hypotheses

Here, we summarise our main hypotheses for two different assumptions regarding firm behaviour. As a benchmark we consider firms to maximise profits. As an alternative we provide hypotheses for the case that firms also care about relative profit levels.

Our first set of hypotheses is about the obfuscation frequency by the two firm types. For profit-maximising firms Proposition 2 suggests that Firm 1 has in general larger incentives to obfuscate than Firm 2:

Hypothesis 1. Firm 1 always chooses obfuscation; Firm 2 chooses obfuscation only in treatments POL and SYM.

With relative profit concerns the predictions are softened in the sense that, depending on the extent of relative profit concerns, Firm 2 may not always choose to obfuscate in treatments POL and SYM. We therefore state as an alternative hypothesis:

Hypothesis 1'. Firm 1 chooses obfuscation more frequently than Firm 2.

Concerning the effects of consumer protection policy, since $x_{\text{BASE}} = 0.2$ and $x_{\text{POL}} = 0.6$, $\tilde{\phi}(x_{\text{BASE}}) < \phi = 0.9 < \tilde{\phi}(x_{\text{POL}})$. With profit-maximising firms it follows from Proposition 5 that Firm 2 switches from no obfuscation to obfuscation while the share of naive consumers remains unaffected as $\frac{1-x_{\text{BASE}}}{2} = 1 - x_{\text{POL}} = 0.4$. Given that the share of naive consumers and asymmetry do not change in the second stage, the pricing equilibrium is also unaffected.

Hypothesis 2. Compared to BASE, in treatment POL: a) Firm 2 always obfuscates; b) The number of naive consumers does not change; c) Prices and consumer surplus do not change.

When relative profits play a role, the effects of regulation may be less strong than under profit maximisation, and we would expect more obfuscation than under BASE, but to a lesser extent than predicted with pure profit maximisation. As a result, the policy might be effective in reducing the number of naive consumers and also in reducing prices:

Hypothesis 2'. Compared to BASE, in treatment POL: a) Firm 2 obfuscates more frequently; b) The number of naive consumers decreases; c) In treatment POL prices are lower and consumer surplus higher.

We now discuss the hypotheses regarding the treatment SYM. With the consumer protection policy being fixed at 0.2, $\phi_{\text{BASE}} = 0.9 > \tilde{\phi}$ while $\phi_{\text{SYM}} =$

$0.6 < \tilde{\phi}$. From Proposition 4, Firm 2 switches from no obfuscation to obfuscation and the number of naive consumers increases from 40 to 80. Regarding the intensity of price competition there are two effects. First, for a given share of naive consumers, price competition is intensified in a more symmetric market. Second, with more naive consumers price competition is weakened. With profit-maximising firms, the second effect dominates and hence, equilibrium prices increase (see Table 2).

Hypothesis 3. Compared to BASE, in treatment SYM: a) Firm 2 always obfuscates; b) The number of naive consumers is higher; c) In treatment SYM prices are higher and consumer surplus lower.

With concerns for relative profits, we would again expect weaker effects on the obfuscation choices. Firm 2 still has stronger incentives to obfuscate under SYM than under BASE, but due to relative profit concerns not all Firm 2 participants may choose to do so. There is no qualitative change regarding the number of naive consumers. Regarding the intensity of price competition, there are again the two opposing effects. However, with concerns for relative profits, the price-increasing effect of more naive consumers is smaller, and the overall effect becomes ambiguous: If the obfuscation effect is large (small) prices increase (decrease).

Hypothesis 3'. Compared to BASE, in treatment SYM: a) Firm 2 obfuscates more frequently; b) The number of naive consumers is higher; c) In treatment SYM the effects on prices and consumer surplus are ambiguous.

4 Results

This section presents the experimental results, and Table 3 contains our main findings. To account for learning effects, all comparisons and tests are based on the last ten periods. We employ non-parametric tests, where the number of independent observations corresponds to the number of matching groups. We report two-sided p-values throughout.

	BASE	POL	SYM
Obf. by Firm 1	0.97	0.94	0.95
Obf. by Firm 2	0.07	0.43	0.58
Naive consumers	41.6	27.4	61.1
Avg. price	69.0	50.5	74.5
Min. price	61.2	45.4	69.5
Cons. surplus	31.0	49.5	25.5

Table 3: Main results

4.1 Obfuscation choices by firm types

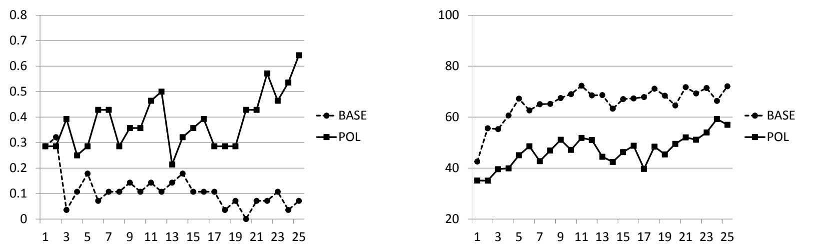
Table 3 reports the average propensity to obfuscate by firm type in each treatment. The table indicates that in all treatments Firm 1 chooses obfuscation more frequently than Firm 2 (Wilcoxon signed-rank test, $p = 0.018$ and 0.018 and 0.028, respectively), providing evidence in favour of Hypothesis 1′:

Result 1. Firm 1 obfuscates more frequently than Firm 2.

Observe that the obfuscation level chosen by Firm 1 is similar and close to one in all treatments (which is in line with hypotheses 1 and 1′), while this is not the case for Firm 2. Indeed, in all treatments (in particular, in POL and SYM) Firm 2's obfuscation rates are far below one, contradicting Hypothesis 1. In the following we focus on Firm 2's behaviour in more detail.

4.2 The impact of consumer protection

We next study the effects of the consumer protection policy on obfuscation decisions by Firm 2. As can be seen in Table 3, obfuscation is more prevalent with the policy in place and obfuscation decisions by Firm 2 are significantly higher with the consumer protection policy (Mann-Whitney rank-sum test, $p = 0.002$). Due to the policy, the obfuscation rate increases from 0.07 to 0.43. The left panel of Figure 1 also reveals a time trend: in the POL treatment



(a) Firm 2's obfuscation rates (b) Average prices paid by all consumers

Figure 1: Impact of consumer protection: evolution of obfuscation rates and prices

obfuscation rates are increasing over time and towards the last periods the obfuscation rate exceeds 60%, but is far below 100%.[9] This gives support for our hypothesis 2'a):

Result 2. The introduction of a consumer protection policy increases the propensity of Firm 2 to obfuscate.

Even though we have observed that Firm 2 obfuscates more in treatment POL, this effect is much lower than predicted by the model under profit maximisation. One possible explanation for this finding, as also discussed in the theory section, may be that participants in the experiment care about relative payoffs and thus exhibit inequality aversion. Our results lend support to hypothesis 2'a) rather than hypothesis 2a). If Firm 2 chooses to obfuscate this not only increases its own profits, but also increases Firm 1's profits. Indeed, profits of Firm 1 increase to a larger extent than Firm 2's profits, decreasing the relative payoff of a Firm 2-player.

Table 4 shows the impact of Firm 2's obfuscation decision on both firms' profits given that Firm 1 has chosen to obfuscate. The table reports the realised profits we observe in the experiment. The table shows that in the

[9]This suggests that some learning effects are present. It might take some time for participants to understand the effects of obfuscation by Firm 2. Therefore, to takes such effects into account all statistical tests are based upon the last ten rounds of the experiment.

Decision by Firm 2	Firm type	observed average profit
no obfuscation	Firm 1	2035
	Firm 2	2028
obfuscation	Firm 1	4008
	Firm 2	2640
Profit change (abs)	Firm 1	1973
	Firm 2	612
Profit change (rel)	Firm 1	0.97
	Firm 2	0.30

Table 4: Average profit levels

treatment POL it is profitable to obfuscate, but it also shows that the profit gap widens. By obfuscating Firm 2 profits rise by ca. 600 while those of Firm 1 rise by ca. 2000. In relative terms Firm 2 profits increase by 30% while Firm 1 profits almost double.

From our experimental data we can elicit the critical degree of inequality aversion from which on a subject does not choose to obfuscate even though obfuscation would increase its material payoff. Analogously to Fehr and Schmidt (1999) the utility of a subject i is given by

$$U_i(\pi_i, \pi_j) = \pi_i - \alpha_i(\pi_j - \pi_i), \tag{4}$$

where α_i is a measure for the extent of the (disadvantageous) inequality aversion of subject i.[10] The critical degree of inequality aversion $\hat{\alpha}$ equalises a subject's utility (taking the role of Firm 2) from obfuscating and not obfuscating. Taking the observed profit levels from Table 4, the critical envy parameter is implicitly given by $2028-\hat{\alpha}(2035-2028) = 2640-\hat{\alpha}(4008-2640)$, which implies $\hat{\alpha} = 0.45$. This means that subjects with an inequality aversion parameter smaller than $\hat{\alpha}$ decide to obfuscate while those with a larger inequality aversion parameter decide not to obfuscate.

The extent of inequality aversion observed in our experiment is similar to other studies. For instance, Blanco et al. (2011) elicit the distribution of the

[10]In Fehr and Schmidt (1999) individuals may also suffer from advantageous inequality aversion when an individual earns a higher material payoff than its comparison group. In our experiment, we do not observe advantageous inequality aversion: Subjects taking the role of Firm 1 almost always choose to obfuscate even though this increases the payoff gap.

inequality parameters by using an ultimatum experiment.[11] According to their results, 33% of their participants have an α lower than 0.4 (close to the critical α in the treatment POL) and 51% an α lower than 0.61. Interpolating their results would yield that around 37% of subjects have an α lower than 0.45. In our experiment, we observe an obfuscation rate of 0.43. Hence, our results are in a similar range, though inequality aversion is slightly weaker in our study.[12]

Though obfuscation choices by Firm 2 increase due to the policy, this effect is not sufficiently strong to weed out the positive effects of the reform, see Table 3. In particular, there is a significant reduction in the number of naive consumers from 41.6 to 27.4 (Mann-Whitney rank-sum test, $p = 0.002$). Moreover, the average price as well as the minimum price in the market drops significantly (Mann-Whitney rank-sum test, $p = 0.006$ for both prices). Accordingly, consumer surplus rises from 31.0 to 49.5 (Mann-Whitney rank-sum test, $p = 0.006$). These results are in line with our hypotheses 2'b) and 2'c).

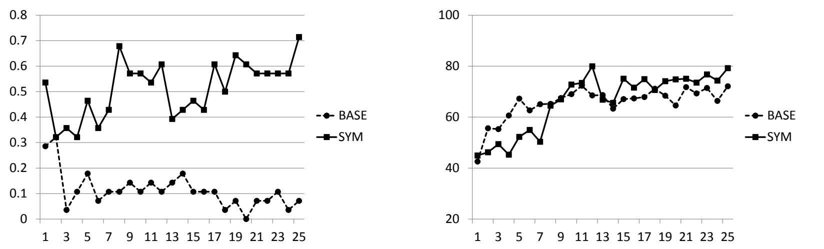
Result 3. The introduction of a consumer protection policy decreases the number of naive consumers. Prices decrease and consumer surplus increases.

4.3 The impact of asymmetry

We now consider the effects of asymmetry by comparing the treatments BASE and SYM. In line with our predictions we find that in a more symmetric market obfuscation rates by Firm 2 are higher. The average obfuscation rate increases from 7% to 58% (Mann-Whitney rank-sum test, $p = 0.007$). This effect is also stable over time, see Figure 2. Note, however, that the

[11] Fehr and Schmidt (1999) also elicit the distribution of the inequality parameter α. However, the intervals are broader than in Blanco et al. (2011) which is why we focus on the comparison with their distribution. Note, however, that the distributions derived in both studies are quite similar.

[12] We note that our results suggest that some level of inequality aversion is present in our framework despite some mitigating effects. For instance, in our design with role switching subjects should be less concerned with relative payoff concerns than in a design without such role switching. However, a random matching procedure may make such differences somewhat smaller.



(a) Firm 2's obfuscation rates (b) Average prices paid by all consumers

Figure 2: The impact of symmetry: evolution of obfuscation rates and prices

strength of this effect again falls short compared to the theoretical prediction under pure profit maximisation, inequality aversion being a potential explanation.[13]

Table 3 reports the effects on the number of naive consumer and prices. As a consequence of a higher obfuscation level we find that the number of naive consumers is larger in the more symmetric treatment. The number of naive consumer rises from 41.6 to 61.1 which is statistically significant (Mann-Whitney rank-sum test, $p = 0.005$). We also see that prices are higher in the symmetric treatment: The average price (minimum price) paid by consumers rises from 69.0 to 74.5 (61.2 to 69.5). However, this price effect is small (Mann-Whitney rank-sum test, $p = 0.142$ and $p = 0.048$; see also the right panel of Figure 2). Consumer surplus decreases from 31.0 to 25.5. Summarising the effects of asymmetry and confirming hypotheses 3 and 3':

Result 4. Obfuscation rates and the number of naive consumers are higher in a more symmetric market. Prices are higher and consumer surplus is lower.

[13]In the treatment SYM, we observe that profits of Firm 1 increase by ca. 2300 while profits of Firm 2 increase only by ca. 750 if Firm 2 chooses obfuscation. This implies a critical inequality aversion parameter of $\alpha = 0.61$. With a Firm 2- obfuscation rate of 0.58 this is in a similar range as the evidence in Blanco et al. (2011).

Treatment	Firm 1	Firm 2
BASE	81.1	66.0
POL	66.5	52.5
SYM	80.6	75.1

Table 5: Average prices by firm type

Treatment	POL		SYM	
	Price	CV	Price	CV
Obfuscation by one firm	46.6	0.54	58.7	0.38
Obfuscation by both firms	66.5	0.36	88.5	0.24

Table 6: The impact of obfuscation on average prices

4.4 Prices

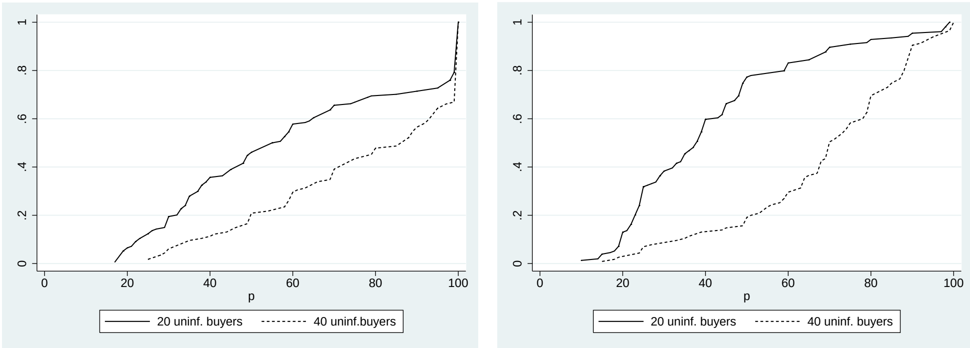
In the following we briefly comment on the price choices in the second stage of the experiment, thereby confirming some existing results and providing some new findings.[14]

As suggested by the theory, Firm 1 attracting a larger share of naive consumers has less incentive to compete on low prices. This is confirmed in the experimental data. As can be seen in Table 5, we find that in all treatments Firm 1 charges higher prices than Firm 2 (Wilcoxon signed-rank test, p-values 0.018, 0.028 and 0.043, respectively).

Result 5. Firm 1 charges on average a higher price than Firm 2.

The theoretical model suggests that in more obfuscated markets competition is weakened and prices are higher. This mechanism is an important reason for firms to obfuscate. We now provide evidence that this is indeed the case. We focus on treatments POL and SYM as only in those two treatments we observe sufficient variation in the number of naive consumers. Table 6 shows that in both treatments average prices rise with more obfus-

[14]Our results suggest that relative profit concerns play less role on pricing decisions than in the obfuscation decisions. Comparing the pricing decisions of subject who frequently obfuscate with those who rarely obfuscate we find that those decisions are quite similar.



(a) Firm 1 (b) Firm 2

Figure 3: The impact of firms' pricing behaviour if obfuscation increases in treatment POL

cation (Wilcoxon signed-rank test, p-value 0.018 in both treatments).

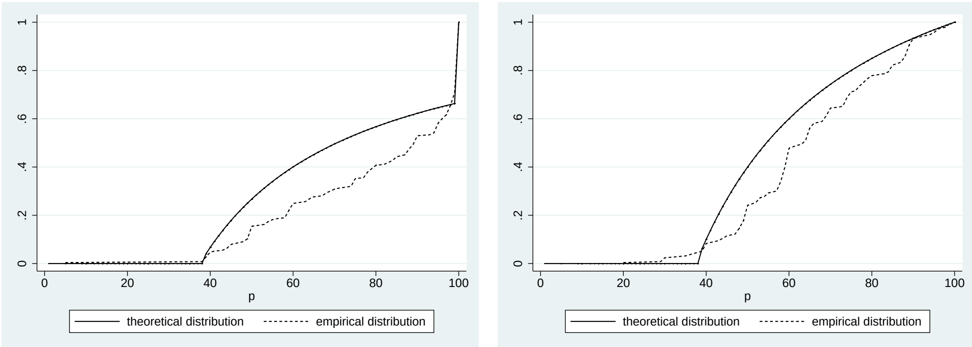
Another way to compare the effects of obfuscation on pricing is by looking at the entire price distributions. Figure 3 plots the observed cumulative price distributions for the treatment POL. The figure shows that the cumulative price distribution for both firms shifts out to the right if the market is more obfuscated and there are more naive buyers. Indeed, obfuscation seems to have a particularly strong impact on pricing by Firm 2. If only one firm obfuscates, the probability of Firm 2 charging a price higher than 50 is low (around 20%); the empirical distribution is rather flat for prices over 50. In contrast, if both firms obfuscate, this probability is four times higher and increases to 80%.[15]

These findings are in line with the ones obtained by Morgan et al. (2006) who show that, in a setting where naive consumers are equally divided among firms, prices rise with more naive consumers.[16] We extend this result to the case with asymmetric firms. We summarise our findings:

Result 6. Prices are higher in more obfuscated markets.

[15]Similar results are obtained if we consider the effects for the treatment SYM.

[16]Relatedly, Kalayci and Potters (2011) report evidence from a laboratory experiment where participants take both the roles of sellers and buyers. Sellers can make price comparisons harder by deciding on the number of attributes of a product. They find that prices increase with the average number of product attributes.



(a) Firm 1 (b) Firm 2

Figure 4: Comparison of the theoretical and empirical price distribution: treatment BASE with 40 naive consumers

Table 6 also reports the coefficient of variation (CV), a common measure of price dispersion. We replicate the finding from Morgan et al. (2006) that price dispersion is higher in markets with more informed consumers (that is, in less obfuscated markets). We find this results in both treatments POL and SYM.

Finally, we briefly comment on the comparison of the theoretical price distribution as predicted by the theory and the observed price distribution. In line with the two-player treatments in Morgan et al. (2006) we find that observed prices are somewhat higher than predicted by the theory. As an example, Figure 4 shows the cumulative price distribution in the treatment BASE with 40 naive consumers. As can be seen the empirical distribution almost dominates the theoretical distribution, leading to higher observed average prices.[17]

5 Conclusion

This paper has studied firms' incentives to obfuscate in a laboratory experiment and the effects of public policies intended to improve market outcomes. Our main result is that protection policies intended to help consumers make good decisions and policies intended to level the playing field between firms may have unintended consequences.

[17]There are qualitatively similar effects in the other treatments.

Regarding consumer protection policies our experimental findings suggest that less prominent firms increase their obfuscation efforts in response to such a policy. However, such policies are still effective in increasing competition, though to a smaller extent than initially expected. We find that policy measures that lead to more equal levels between firms lead to worse market outcomes. Both the obfuscation level and the price level rise following such an intervention.

A Pricing when managers are concerned of relative profits

Here we briefly discuss pricing and obfuscation incentives when managers are concerned of relative profits. We focus on the case where the level of profit concerns of managers is identical and publicly known.

The managers of the firms are concerned of relative profits. The utility of manager $i = 1, 2$ is

$$U_i = \Pi_i + \alpha(\Pi_i - \Pi_j), \tag{5}$$

where Π_i are the monetary profits and $\alpha > 0$ measures the degree of concern for relative profits. In the pricing stage, the managers simultaneously and independently select prices to maximise their utility.

As in the standard case pricing is in mixed strategies. Firm 1 prices according to the cumulative distribution function

$$F_1(p) = 1 + \frac{(1-\phi)\mu}{1-\mu} - \frac{\phi\mu(1-\phi\mu)}{(1-\mu)[\phi\mu + (1-\mu)]}\left(\frac{r}{p}\right)^{\frac{1+\alpha}{1+2\alpha}}, \tag{6}$$

and Firm 2 prices according to the cumulative distribution function

$$F_2(p) = 1 + \frac{\phi\mu}{1-\mu} - \frac{\phi\mu}{1-\mu}\left(\frac{r}{p}\right)^{\frac{1+\alpha}{1+2\alpha}} \tag{7}$$

on $[p_0, r]$ and $[p_0, r)$ resp., where $p_0 = r\left(\frac{\phi\mu}{\phi\mu+(1-\mu)}\right)^{\frac{1+2\alpha}{1+\alpha}}$.

The main properties are preserved from the case with no relative profit concerns (Gu and Wenzel, 2014). Both firms randomise over prices, and on average Firm 1 charges higher prices than Firm 2. More precisely, as $\partial F_1(p)/\partial\alpha > 0$ and $\partial F_2(p)/\partial\alpha > 0$ prices with relative profit concerns are stochastically dominated by prices in the case with pure profit maximisation ($\alpha = 0$).

Finally, we briefly discuss that the incentives to obfuscate are similar as in the standard case, but the incentives for Firm 2 to obfuscate decrease with the extent of relative profit concerns. At stage 1 the utility of Firm 1 manager is

$$U_1 = (1+\alpha)\phi\mu r - \alpha[(1-\phi)\mu + (1-\mu)]E(p_2), \tag{8}$$

which can be shown to be increasing in μ so that also in the case of relative profit concerns Firm 1 would like to obfuscate as much as possible. Firm 2 manager earns utility of

$$U_2 = (1+\alpha)[(1-\phi)\mu + (1-\mu)]p_0 - \alpha\phi\mu E(p_1). \tag{9}$$

As in the standard case whether or not Firm 2 manager would like to increase obfuscation depends on the asymmetry ϕ. It also depends on the relative profit concerns. Particularly, one can show that Firm 2 prefers less obfuscation for higher values of α.

B Instructions

Welcome to this experiment in decision making. Please read the instructions carefully.

During the experiment you can earn points depending on your own decisions and those of the other participants. At the end of the experiment points are converted at a rate of 10.000 points = 1 EUR and paid to you.

You are starting with an amount of 40.000 points. This amount is increased by the earnings in each period.

The setup

In this experiment you are assigned the role of a seller. In each period of the experiment you are competing with another seller which is randomly determined among the other participants of the experiment. Your competitor is determined each round anew so that in each round you are competing with another participant.

There are two types of sellers, type A and type B, who interact with each other. Which role is assigned to you is determined at the start of each period and is communicated to you. If you are a seller of type A you are interacting with a seller of type B.

You and the other seller are selling a good to 100 buyers. Each buyer purchases exactly one unit of the good. The buyers are simulated by the computer. There are two types of buyers: “searching” and “non-searching” buyers. A “searching” buyer purchases the good from the seller that has chosen the lower price. “Non-searching” are programmed such that a share of 90% (60%) automatically purchases from the seller of type A and a share of 10% (40%) automatically purchases from the seller of type B.

In each period of the experiment you have to make two decisions which are described in the following.

The first stage

In the first stage of each period, both sellers simultaneously decide whether to increase the number of “non-searching” buyers. In the initial situation, there are 0 “non-searching” buyers and 100 “searching” buyers. For each seller deciding to increase the number of “non-searching” buyers , the number of “non-searching” buyers is increased by 40 (20). The number of “searching” buyers is decreased accordingly. The following table shows the number of “non-searching” and “searching” buyers depending on the decisions of both sellers:

Number of sellers deciding to increase the number of “non-searching” buyers	0	1	2
“Non-searching” buyers	0	40 (20)	80 (40)
“Searching” buyers	100	60 (80)	20 (60)

The second stage

In the second stage of each period, you receive information on the decisions taken in the first stage, and thus you receive information on the number of “searching” and “non-searching” buyers. Subsequently, both sellers simultaneously decide on the price they charge. The chosen price must be an integer between 0 and 100.

End of each period

At the end of each period, the computer calculates how many units you and the other seller have sold. Note that each buyer buys exactly one unit of the good. The number of sold units is calculated as follows:

- your share of the non-searching buyers will buy from you

- searching buyers will only buy from you if you have chosen a lower price than the other seller. In case both sellers choose the same price a share of 90% (60%) of those consumers will buy from the type A seller and a share of 10% (40%) will buy from the type B seller.

Finally, you receive information about the points that you earned in this period. The number of points earned is the number of sold units multiplied by the price you have chosen.

End of the experiment

The experiment is repeated for 25 rounds. Whether you take the role of seller A or B is randomly determined in each period. At the end of the experiment your earnings will be paid out to you. Your earnings comprises the show-up fee and the points you have earned during the experiment.

References

Armstrong, M. and Huck, S. (2010). Behavioral economics as applied to firms: A primer. *Competition Policy International*, 6(1):3–45.

Blanco, M., Engelmann, D., and Normann, H.-T. (2011). A within-subject analysis of other-regarding preferences. *Games and Economic Behavior*, 72(2):321–338.

Calvet, L. E., Campbell, J. Y., and Sodini, P. (2007). Down or out: Assessing the welfare costs of household investment mistakes. *Journal of Political Economy*, 115(5):707–747.

Calvet, L. E., Campbell, J. Y., and Sodini, P. (2009). Measuring the financial sophistication of households. *American Economic Review*, 99(2):393–398.

Campbell, J. Y. (2006). Household finance. *Journal of Finance*, 61(4):1553–1604.

Carlin, B. I. (2009). Strategic price complexity in retail financial markets. *Journal of Financial Economics*, 91(3):278–287.

Chioveanu, I. and Zhou, J. (2013). Price competition with consumer confusion. *Management Science*, 59(11):2450–2469.

Crosetto, P. and Gaudeul, A. (2014). Choosing whether to compete: Price and format competition with consumer confusion. Unpublished working paper.

Fehr, E. and Schmidt, K. M. (1999). A theory of fairness, competition and cooperation. *Quarterly Journal of Economics*, 114(3):817–868.

Fischbacher, U. (2007). z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, 10(2):171 – 178.

Gibbons, R. and Murphy, K. (1990). Relative performance evaluation for chief executive officers. *Industry and Labor Relations Review*, 43(3):30–51.

Gu, Y. and Wenzel, T. (2014). Strategic obfuscation and consumer protection policy. *Journal of Industrial Economics*, 62(4):632–660.

Hehenkamp, B. and Wambach, A. (2010). Survival at the center - The stability of minimum differentiation. *Journal of Economic Behavior and Organization*, 76(3):853–858.

Huck, S. and Zhou, J. (2011). Consumer behavioral biases in competition: A survey. Unpublished working paper.

Kalayci, K. (2012). Confusopoly: Competition and obfuscation in markets. Unpublished working paper.

Kalayci, K. (2015). Price complexity and buyer confusion in markets. *Journal of Economic Behavior and Organization*, 111(0):154–168.

Kalayci, K. and Potters, J. (2011). Buyer confusion and market prices. *International Journal of Industrial Organization*, 29(1):14–22.

Lusardi, A. and Mitchell, O. (2007). Baby boomer retirement security: The roles of planning, financial literacy, and housing wealth. *Journal of Monetary Economics*, 54(1):205–224.

Miravete, E. J. (2013). Competition and the use of foggy pricing. *American Economic Journal: Microeconomics*, 5(1):194–216.

Morgan, J., Orzen, H., and Sefton, M. (2006). An experimental study of price dispersion. *Games and Economic Behavior*, 54(1):134–158.

Narasimhan, C. (1988). Competitive promotional strategies. *Journal of Business*, 61(4):427–449.

Normann, H.-T. and Wenzel, T. (2014). Shrouding add-on information: an experimental study. Unpublished working paper.

Piccione, M. and Spiegler, R. (2009). Framing competition. UCL-ELSE Working paper No. 336.

Piccione, M. and Spiegler, R. (2012). Price competition under limited comparability. *Quarterly Journal of Economics*, 127(1):97–135.

Schaffer, M. (1989). Are profit-maximisers the best survivors? A Darwinian model of economic natural selection. *Journal of Economic Behavior and Organization*, 12(1):29–45.

Sitzia, S. and Zizzo, D. (2011). Does product complexity matter for competition in experimental retail markets? *Theory and Decision*, 70(1):65–82.

Spiegler, R. (2011). *Bounded Rationality and Industrial Organisation*. Oxford University Press.

Spiegler, R. (2014). Competitive framing. *American Economic Journal: Microeconomics*, 6(3):35–58.

Stango, V. and Zinman, J. (2009). Exponential growth bias and household finance. *Journal of Finance*, 64(6):2807–2849.

van Rooij, M., Lusardi, A., and Alessie, R. (2011). Financial literacy and stock market participation. *Journal of Financial Economics*, 101(2):449–472.

Varian, H. R. (1980). A model of sales. *American Economic Review*, 70(4):651–659.

Wilson, C. and Waddams, C. (2010). Do consumers switch to the best supplier? *Oxford Economic Papers*, 62(4):647–668.